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ABSTRACT

Two booklets, a guide and handbook, comprise the K-3 component of a series of guides for incorporating environmental education into the existing curriculum. The materials emphasize a multidisciplinary approach, use the concept of interdependence as an organizing theme, and offer suggestions for using the local community as a resource. The guide outlines eight objectives, including understanding of the relationship of parts of a system to the whole and using skills from many subject areas to explore the student's environment. Activities and bibliographic resources are provided for helping children learn about families and cities as systems, interdependence of people and plants, and use of tools to help people interact with the land. The handbook contains 12 lessons which are either concept-building exercises or activities in which students use the concept to explore various content areas. For each lesson, the goal, objective, materials, procedure, follow-up activities, and alternative learning activities are presented. Students examine the workings of a retractable ball-point pen, try to perform normal class activities with thumbs taped down, identify all the systems each student belongs to at any particular moment, and explore problems of overcrowded systems. (AV)

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Part A
K-3 Guide

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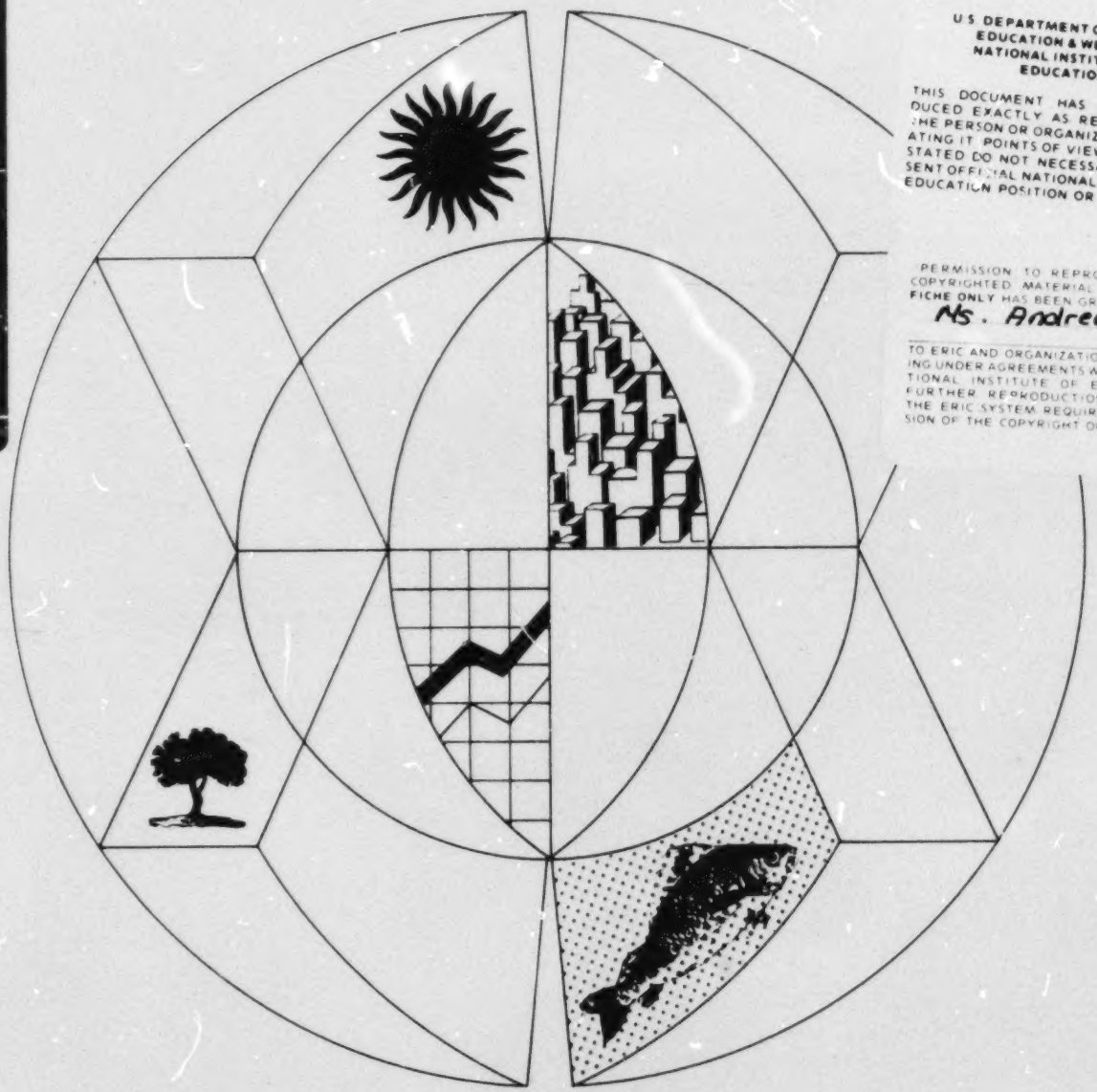

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Environmental Education
Interdependence: A Concept Approach

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CENTER FOR GLOBAL PERSPECTIVES

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ENVIRONMENTAL EDUCATION

INTERDEPENDENCE: A CONCEPT APPROACH

SUGGESTIONS FOR CURRICULUM DEVELOPMENT

PART A, K-3

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ENVIRONMENTAL EDUCATION

INTERDEPENDENCE: A CONCEPT APPROACH

INTRODUCTION TO THE SERIES

PURPOSE

The purpose of this series of guides is to provide:

- strategies for incorporating environmental education into the existing curriculum (it is not a blueprint for a new course);
- a variety of ideas, questions to explore, and suggestions for lessons and activities which will allow teachers and curriculum developers to select those portions which best meet their particular needs;
- exemplary lessons -- which should prove useful in themselves and also offer ideas for your own curriculum development;
- an emphasis on multi-disciplinary approaches, since study of the environment is not limited to any single discipline or subject area;
- suggestions for using the local community as a resource for learning about population and other environmental concerns;
- an organizing theme around the concept of interdependence -- a conceptual lens which will provide students with a new way of organizing information and of looking at the world around them.

EDUCATION FOR ENVIRONMENTAL HEALTH

> Environmental education is not a new class to teach. Rather it is a fresh way to approach, consider and apply what you are already teaching in the classroom.[1]

> When we move into the areas of the social sciences, arts, and humanities, which once were considered unrelated, the outlines of a curriculum begin to emerge that not only will help children understand their interdependence with the natural world, but will help them develop the skills, attitudes, and knowledge necessary to understand and solve environmental problems.[2]

These two quotations stress the same point: environmental education is an integral part of the existing curriculum rather than a separate area of study. Perhaps that needs to be explained a little more fully.

Environmental education involves more than concern for the protection of wildlife or awareness that humans are poisoning the environment. Conservation and awareness are important, but they are only parts of a larger whole. In its fullest sense, environmental education involves *the individual's relationship to his or her total environment* -- and that includes the built environment as well as the natural. Every course we teach has something to do with how people relate to each other and to their world.

From every corner of the curriculum, then, there can emerge the skills, attitudes and information young people need for a creative approach to their environment. The major goal of environmental education is not to persuade students to launch or participate in anti-pollution campaigns. Much more basic is the objective of helping them learn to use all their senses to "reconnect" them with their natural and human-made surroundings. Each of us shapes and is shaped by the environment. The challenge to educators is to provide an education that will enable people to recognize areas of individual and

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[1] The American Institute of Architects, *Built Environment; a Teacher Introduction to Environmental Education*, 1975, p. 7.

[2] *Ekistics*, A Guide for the Development of an Interdisciplinary Environmental Education Curriculum, California State Department of Education, Sacramento, 1973, p. v.

group responsibility for their surroundings. They can then work intelligently toward structuring a healthy environment, instead of passively accepting whatever they find around them. Such a goal becomes increasingly vital as our world becomes more crowded and more urbanized.

INTERDEPENDENCE: THE ORGANIZING THEME

The idea of *interdependence* is deceptively simple. It means *mutual dependence* -- parts of the whole depending on each other. The term has become popular in the past few years as a key means of describing the nature of life on our planet. Such terms as Spaceship Earth or Global Village are more dramatic ways of stating the fact that we live in an increasingly interdependent world where the parts of the whole depend more and more on each other.

We constantly encounter interdependence in our daily lives and in the subjects we teach. When children learn about families or communities, they are learning about interdependent relationships. Similarly, the study of life in the ecosystem of a pond is a study of systems -- or interdependence -- as is the study or analysis of the functions of different aspects of government, the workings of an economy, or the interaction of characters in a play.

Although much of what we teach deals with interdependence, we have not really tried to help students understand the concept itself. Events are too often treated as isolated phenomena. Children are not trained to see a similarity between, say, what's involved in a unit on buying and selling and what happens in the microscopic life of a pond. One similarity is that both involve systems (interdependence).

This set of guides uses examples of systemness or interdependence to help students understand the concept. There is an underlying assumption: as young people become more familiar with the concept, they become better equipped to understand and cope with interdependence -- whether it involves their relations with others, with their environment, or with a subject being studied in school. Here is a simple example:

Without any major changes in curriculum, the child begins to see his or her world as being made up of an endless series of systems and subsystems. A tree is a system; so is the human body. A road map describes a road system; an equation describes a numbers system. A house is a system, so is the neighborhood, and the community is an even larger system composed of hundreds of subsystems. Through experience, the child becomes able to see the world through a systems lens; where appropriate, he or she puts on the systems spectacles and can then see how parts of a whole relate to each other, how the system

functions, what variables might interfere with its smooth operation, how it is similar to and different from other systems.

The concept thus becomes a tool to use for organizing information. With increased experience it can be applied to ever-more complex and sophisticated subject matter. An increase in population can be analyzed in terms of the many systems and subsystems involved. The student automatically knows what questions to ask about the consequences of this population change on space, food, light, other species, and so on. Students will develop the skills needed to minimize the negative results of systems change on their own lives. Finally, understanding of the concept enables the person to recognize the interactions between self and immediate surroundings and between immediate surroundings and the total environment of the planet itself.

This conceptual lens is not magic, nor does it provide everything people need to know to understand their relationship to their environment. But it does provide part of the equipment people need to attain that understanding and to respond to it in creative ways.

We said earlier that the idea of interdependence is deceptively simple. Obviously younger children will deal with it on less complicated levels, applying it to their familiar surroundings. However, when high school students explore the intricacies of global interdependence, they will be aware of the complexities, pressures, and tensions involved.

Robert G. Hanvey describes the complex nature of the subject:

> How does the world work? As a system. What does that mean? It means put aside simple notions of cause and effect. Things interact, in complex and surprising ways. "Effects" loop back and become "causes" which have "effects" which loop back...It means simply that events ramify -- unbelievably.[3]

Consider an example: The Organization of Petroleum Exporting Countries (OPEC) quadrupled the price of oil. This caused an increase in the price of petroleum-based fertilizers (effect), which in turn made it difficult (cause) for a farmer in India to produce a good crop yield (effect) since the new strains of grain developed by the Green Revolution, created (cause) to increase world food supply (effect).

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[3] Robert G. Hanvey, *An Attainable Global Perspective*, Center for War/Peace Studies, 1975.

rely heavily on those fertilizers. At the same time the oil price increase set off other chains -- increased inflation, the decision to build the Alaska Pipeline, lessening of aid to poor countries, and so on. A student with a solid background knowledge of interdependence has the tools to analyze and understand such a maze of interrelated events.

USING THE GUIDES

The curriculum guides are divided into grade clusters (K-3, 4-6, 7-9, 10-12). In each, we have presented a framework or outline describing ideas, suggestions, and activities for topics normally taught at these grade levels. The suggestions listed under each topic will indicate ways you can use your existing course work to develop better understandings of population and other environmental concerns through the concept of interdependence.

When you are planning a unit of study, refer to the relevant portions of the guide. Incorporate some of the activities or exploratory questions into your lesson plans. The guide, then, becomes something like a transparency that you place over your unit plans in order to see where you can add important elements of environmental education. You will also find that the sample lessons can be used for certain key topics, and as models for developing your own lessons.

While many of the topics listed in the guide emerge from social studies, we will frequently be crossing over into art, literature, science, and mathematics. This interdisciplinary approach will probably be easy for elementary-grade teachers to handle. In middle and upper grades, combining courses is more difficult, since there is often little coordination among teachers of different subject areas. We strongly urge team-teaching wherever possible, or at least a close working relationship among teachers. The students will gain tremendous benefits if there is a meshing of subject areas in dealing with environmental education. Faculty or inter-departmental meetings can be used to work out broad areas of coordination among the various subjects.

RESOURCES AND BIBLIOGRAPHIES

Even though most teachers are familiar with the basics of curriculum planning and development, they may find it desirable to review some of the current literature. Two extremely helpful reference books are *Education Index and Books in Print.* Look under subject areas such as "curriculum," "environmental education," or "conservation education." In addition, Educational Resources Information Center (ERIC) publishes a monthly index, *Research in Education* (RIE) which has an excellent collection of environmental education documents, including many produced by some interesting programs supported by HEW under Title III and the Environmental Education

Act of 1970. All three publications are found in most major libraries.

If you wish to develop materials especially for your local needs and resources, you should get in touch with the directors of model programs throughout the country. Their names, addresses, and telephone numbers are listed in *A Directory of Projects and Programs in Environmental Education for Secondary Schools* by John F. Desinger and Beverly Lee (ERIC, The Ohio State University Press, 400 Lincoln Tower, Columbus, Ohio 43210). Also see *Environment U.S.A.: A Guide to Agencies, People and Resources* (R.R. Bowker, P.O. Box 1807, Ann Arbor, Michigan 48106. 1974)

At the end of each unit in this Guide, you will find additional resources. They are by no means complete or comprehensive, but are intended to serve as general and supplemental readings. You may also discover that readings listed in one unit will be helpful in expanding material found in another unit of the Guide. We hope that the Guide, and the references, will provide you and your students with additional ideas for developing the curricula.

SUGGESTIONS FOR CURRICULUM DEVELOPMENT

ENVIRONMENTAL EDUCATION

PRIMARY GRADES (K-3)

INTRODUCTION

In terms of education about population and other environmental issues, there are two key factors to keep in mind.

First, the concept of interdependence is essential to any understanding of the nature of our world. It is important to view the planet as a single system, with all living things dependent on the same inter-related life-support systems. Danger to one portion of one support system is danger to the entire system. When we deal with local issues, then, we should try as much as possible to place these in the global setting -- to see water pollution as a problem for the living things that depend on, say, Lake Erie, but also a threat to the entire Earth water system.

Second, and this may seem a contradiction, it's just as important for children to know more about their immediate surroundings. The classroom, the playground, the home, the neighborhood -- they should see the local setting as the environment they are most involved in and responsible for.

In terms of awareness, then, the goal is to see the total world picture. In terms of responsibility and effective action, our goal at this age level is to appreciate and improve our own compartment on the Spaceship.

If you think of *interdependence* as a vocabulary word, it's a little frightening; but as an organized collection of ideas -- a concept -- it's much more manageable and teachable.

Children, for example, are quick to grasp the meaning of *systems* -- the idea that parts must function with respect to each other for the whole thing to work. They can also understand that systems can be composed of a number of subsystems, as in a car or a human body. The understanding of systems is a good beginning to the understanding of interdependence. This idea can readily be applied to objects around children, and then to human systems and systems in the natural environment. From the start, the knowledge of systems becomes a connecting link, a concept that helps students see relationships among a wide variety of phenomena. This beginning understanding, then, helps children to organize information; it also helps them see relationships between themselves and the world around them.

The more practice children have with the concept, the more they will be able to use it as a tool to gain new insights into topics they study. They will be better equipped to deal with more complex systems in later years.

Using the Outline

It's not a bad approach to conceive of this Topic and Idea Outline as a transparency to be laid over the curriculum. It's designed to show you where you can add important elements to what you already teach, rather than to suggest radical changes.

Skim through the guide. You are likely to find major ideas or topics that touch on what you already teach. For these, read the suggestions for development of study questions, activities, and lessons. Chances are you are already doing some of these. But some of the other ideas can be added to your lesson plans to provide the students with a firmer understanding of the concept.

For each topic or idea, don't feel you have to follow all the suggestions. Instead, select those which adapt most easily to your course materials and teaching practices.

OBJECTIVES

(We state below a series of broad objectives. The teacher should select at least one of these to be the focus of every lesson developed from the guide.)

1. To use knowledge and skills from many subject areas to explore and better understand the student's environment.

   Example: Science, literature, and art can be combined in the exploration of the classroom or playground.

2. To become familiar with the meaning of systems and subsystems.

   Example: Given a familiar toy, the young child observes that it is the combination of parts (subsystems) which forms the whole.

3. To better understand the concept of interdependence.

   Example: Given a flashlight, the child describes the systems present and explains how the parts of the system interact.

4. To recognize that the proper working of the whole system depends on the well-being of each of of its parts.

   Example: The child describes why a toy car with broken or missing parts does not function properly.

5. To understand that equal care must be taken to maintain the well-being of all the parts if the whole is to work as an efficient system.

   Example: The student returns all the pieces of a puzzle or game to their proper places so that they might be used again.

6. To understand that they and other people are important parts of systems.

   Example: Given the names of familiar people systems, the child stands up each time he or she is a member of that system.

7. To understand the pressures of over-populated systems.

   Example: After having the size of the group increased without an increase in the group's resources (e.g., number of chairs), the child discusses the problems of over-population.

8. To understand that the care and correction of systems is for the well-being of all.

   Example: In a walk around the community, the child identifies overcrowded systems and discusses ways each system might be cared for and corrected

TOPIC AND IDEA OUTLINE

GETTING STARTED

GOAL

To understand the nature of systems, and to apply this knowledge to familiar objects and relationships.

OBJECTIVES

Students will

1. describe the functioning parts of familiar objects that make them systems;
2. make generalizations about what happens if one part of a system does not function;
3. make comparisons between animal and human families as systems;
4. observe and report on ways interdependence helps animals meet basic needs.

A. Understanding systems

A key place to begin understanding interdependence is with the idea of *systems*. This learning will be fun and exciting, and will involve the children in true discovery learning.

Because this beginning is so important, the Handbook, accompanying this Guide, contains a series of lessons for teaching about systems. If you don't use all of the sample lessons, at least use some from Parts I, II and III.

B. Beginning to apply systems knowledge

You don't have to deal with systems every day. But, where appropriate, remind the class of their systems activities and have them use the ideas. Here are some beginning possibilities.

1. When learning about animals in stories or texts:

   a. Ask the children to point out ways that baby animals *depend on parents.*

   b. Do members of animal families depend on each other?

      - In what ways? (protection, food, etc.)

      - Is an animal family a *system?* How would you know? (Parts must work together.)

   c. How do animals work together to meet their basic needs?

      Observe animals in real life or a film and have the children look for ways they help each other.

Or, study the cooperative work of ants: Place a tablespoon of sweet syrup in an empty lot or a corner of the playground. Pair pairs of students as observers. When an ant discovers the treasure, what does it do? (It will bring other ants until an entire colony is at work. You can explain that the ants "communicate" by secreting a chemical which other ants follow.)

d. How do animals depend on their environment?

Use pictures, and have volunteers point out ways animals depend on the environment for food, for protection, often for shelter.

e. Point out ways that animals help the environment.

You might talk about nature as a large system, made up of smaller systems. Or introduce the term *ecosystem.*

Children can discover ways animals help keep a natural system in balance, such as:

- earthworms as cultivators
- beavers as builders of dams
- predators as population controllers
- scavengers as waste disposers

All animals provide food for others (or some other service to the system) and, when they die, return important chemicals to land or water.

2. *People systems*

a. Families as systems -- see Handbook, Part III, Lesson 2.

For reinforcement, use stories and talk about ways family members *depend on each other.* Example: *Nicky's Sister* by Barbara Brenner (Knopf).

b. Social studies texts are likely to deal with play, school, or work groups. Where appropriate, ask the class if the groups are systems.

- What makes them systems? What parts do different individuals have to perform?
- What can we do when a system isn't working well?

3. *Neighborhoods and communities*

The students can become aware of larger and more complex systems as they learn about neighborhoods and communities. Emphasize the idea of *depending on each other*, not just depending on others.

a. Make a mural of Things We Depend On -- either in the neighborhood or community.

Children can draw their own pictures. Some classes become involved in resources and quickly discover that things we get in the community come from far away. (This discovery, if made, helps children sense the size and complexity of systems we belong to.) Ask the children how they are part of the systems in the mural.

b. Maps of neighborhoods and communities are good for showing systems. Streets, for example, form systems. Simple work with maps will help visualize systems.

c. Divide the class into groups, supplying each with three or four pictures showing such items as delivery trucks, farms, fishermen, store clerks, firemen.

Ask each group to make a list of what we need these people or things for. The groups can then report their findings to the class.

Point out that your town or city is a system. The jobs we depend on are parts of the system. Ask what would happen if one part didn't work, like firemen or truck drivers.

After the reports, ask if each of these objects or people depends on us and our families.

As a follow-up, children could find out what their parents' occupations are and tell how they fit into the community system.

ADDITIONAL RESOURCES

Picture Books

When Winter Comes. Charles P. Fox. Chicago: Reilly and Lee, 1962. How small animals live in winter.

Thief In The Attic. Kurt Wiese. Garden City, N.Y.: Doubleday. Animals live together in a hollow tree until a crow moves in.

Your Breakfast And The People Who Made It. Kurt Wiese. Garden City, N.Y.: Doubleday, 1954.

Fiction (appropriate reading for 1st-3rd graders)

The Hole In The Tree. Jean C. George. New York: E.P. Dutton, 1957. The old apple tree in the backyard has a very special hole; as it grew, it housed bugs, bees, and chickadees.

Non-fiction

At Home In Its Habitat. Phyllis S. Busch. Cleveland: Collins, Williams and World Publishing Co. Shows interrelationships of living things and their environment.

Big Island. Julian May. Chicago: Follett Publishing Co., 1968. The ecology of an island intertwined with the life of a moose.

From Field To Forest: How Plants and Animals Change the Land. Lawrence P. Pringle. Cleveland: Collins, Williams and World Publishing Co.

In A Beaver Valley. Lawrence P. Pringle. Cleveland: Collins, Williams and World Publishing Co. The total effect of a colony of beavers on the life systems of a valley.

Teacher References

Protection And Conservation Of Life, Health, Natural Resources. Project People. Oklahoma City Public Schools, 900 North Klein Street, Oklahoma City, Oklahoma 73106.

Interdependence, Part A. David C. King. Center for Global Perspectives. Developed as part of the project, Global Perspectives: A Humanistic Influence on the Curriculum, 1975.

EXPLORING NATURE: WE DEPEND ON PLANTS. DO PLANTS DEPEND ON US?

GOAL

To understand ways humans depend on elements of the natural environment and to recognize humans' responsibility for the natural environment.

OBJECTIVES

On the basis of lessons focusing on the concept, students will

1. give examples of ways humans use (depend on) trees and other plants;
2. identify objects around them that are made of wood;
3. classify food items as plant or non-plant;
4. give examples of ways trees are misused or over-used;
5. express increased awareness of humans' responsibility for the natural environment.

A. We Depend On Trees

1. Trees as systems: Use pictures in science texts to have children point out the parts of the tree system.

   Ask: What other things (or systems) does the tree system need? (Water, soil, sun)

2. Provide pictures of different kinds of trees, forests, aspects of the logging industry, trees at a sawmill, boards in a lumber yard. Ask the class what we need or use wood for.

   a. There will be some quick answers, but children often have difficulty distinguishing wood from non-wood products.

   b. Have the children feel, touch, tap wooden objects in the classroom.

      You might point out that you can sometimes tell what kind of tree was used. (a lumber yard can give you color cards showing the grains of different woods; two common varieties good for contrast are oak and pine.)

      You might have children try making crayon rubbings of different wood grains.

      Have children find objects at home made of wood and describe them.

3. Using pictures and/or text materials, develop a lesson to show that we depend on trees for

paper	packaging	oxygen
furniture	boxes	beauty

a. Needing trees for oxygen can be developed in a science lesson.

(Note: Oxygen production through photosynthesis may not be covered in your science texts. You can simplify by pointing out that all animal life, including humans, need oxygen in the air they breathe. Plants help all living things by producing oxygen. Your science text is likely to have a simple experiment to show plants making oxygen -- usually using the water plant called Anachris.)

b. Then deal with trees as objects of beauty. Show pictures of woods and forests. Ask the children to imagine themselves in the pictures. What do they see, smell, hear, feel?

This can also be used for story writing.

c. Next, have them imagine the scenes if all the trees were gone.

How have things changed without trees?

Notice if anyone asks what would happen to the oxygen supply.

> If this comes up, take time to point out that we depend on the *total* air system of the whole planet. You might ask what would happen if there were no plants at all to produce oxygen.

d. Supply old magazines for the children to find pictures of ways we need trees; use the pictures for a bulletin board display.

e. For enrichment, use story or activity books about trees and other plants. Example: A. Harris Stone and Darian Brooks, *Days in the Woods* (Prentice-Hall, 1972) tells young children how to explore what is going on in the woods. For strictly urban settings, try Phyllis S. Busch, *A Walk Along a City Street* (Lippincott, 1972).

4. Making choices: Should people help trees?

a. Use pictures of lumbering and saw mills to show how we get the logs we use for wood products.

Ask the class to tell why we have to be careful not to use trees too fast.

b. Show other pictures of de-forested hills and trees damaged by air pollution. You can also show how construction of highways and buildings removes trees.

Additional pictures should show what the lumbering industry does to replant trees.

Ask: What should we do to help trees?

You may want to use this to launch a tree-planting activity, if this can be arranged with school administrators. The project will certainly give the children the feeling that they are making an important contribution.

B. We Depend on Other Plants

1. Using pictures and yarn, help the class make bulletin board lists of foods that come from plants.

Choose a basic food, like corn or wheat, and ask children what it is used for. Corn, for example, can be used for things like corn bread, creamed corn, popcorn, cereal, syrup, corn starch (useful for puddings, etc.).

Children can check the ingredient labels on packages at home for more ideas. A brief film called *Plants Make Food* (Churchill Films, 11 min.) is good for this topic.

2. Food systems -- how did breakfast arrive?

You can expand understanding of interdependence by dealing with some of the systems involved in the journey of corn or wheat from farm to breakfast table.

a. Through pictures or text materials you can help the class list different systems that bring us breakfast.

The grain is milled; it's shipped by rail or ship; a cereal company adds other ingredients; packaging is needed; you might even mention advertising -- how do we find out about new cereals? Trucks or trains bring the cereal to our community, eventually to the local grocery store.

A useful set of filmstrips on this is *How We Get Our Foods* (Society For Visual Education).

b. Questions to ask:

- Do we depend on many people for our breakfast?

- How do they depend on us?

- Can people far away depend on each other?

- Do we have to see or know the people we depend on?

c. It's important for children to understand many examples of interdependence, not merely those involving environmental concerns.

3. Competition for food

By the 2nd or 3rd grades, course material usually gets at the idea that there is often conflict over meeting basic needs. Plants and animals compete for the same resources (light, space, food, water). Some ways to develop this idea:

a. Read the story of Peter Rabbit. What kind of conflict did Peter have with the farmer?

- Do humans compete with animals for food?

- What are some other examples besides rabbits?

b. If the children have already had some experience with ecosystems or the balance of nature, you can raise this question: would it be a good idea to get rid of all the animals that eat the same food we do?

ADDITIONAL RESOURCES

Fiction

The Tree. Donald Carrick. New York: MacMillan, 1974. A young boy watches his favorite tree cut down and sent to make boards. He and his father bring these boards home and make a chair.

Non-fiction

Big Tree. Mary H. Buff. New York: Viking Press, 1946. The life cycle of a forest as seen by a big tree growing in the middle of the woods.

The Forest and Man. George McCue. Beverly Hills, California: Benziger, Bruce & Glencoe, Inc., *Web of Life Series. 1971.*

Teacher References

Tree Watching. Minnesota Environmental Sciences Foundation, Inc., 5400 Glenwood Avenue, Minneapolis, Minn. 55422.

MEETING BASIC NEEDS

At some point in the K-3 curriculum, children learn about ways plants and animals meet their basic needs. You can use these studies to develop understanding of important environmental topics, including the effects of overcrowding.

GOAL

To demonstrate that plants and people have certain basic needs, including the need for space.

OBJECTIVES

Students will

1. make guesses (simple hypotheses) about how plants will grow under different conditions;
2. compare plant needs and human needs;
3. observe overcrowding in their surroundings;
4. infer that both plants and people suffer if overcrowded

A. Plants Have Basic Needs

1. Use a study of growing plants in pots to illustrate the needs of plants for light, water and space.

   a. Plant seeds (beans or peas) in four different pots. Thin the sprouts in all pots but one, which will be used to show the effects of crowding. This pot should have plenty of seeds.

      - Tell the class that pot #1 will not be watered for a few days.
      - Cover pot #2 with cardboard or foil to block out sunlight.
      - Point out that pot #3 is very crowded.
      - Pot #4 will receive normal amounts of water, light, space.

b. Ask the children to guess what each pot will look like after four days. You might write their guesses on the board and save them.

c. After four days, observe the differences. (It may take longer to show the effects of crowding.)

- Ask why each of the first three pots did poorly.

- What did pot #4 have that allowed it to do better? (light, water, space)

2. On a field trip: Around the school or in a field, find plants which have trouble meeting their basic needs. Examples:

- Plants that aren't receiving enough water -- perhaps too sheltered by trees or buildings.

- Plants that aren't receiving enough light -- turn over rocks or boards to reveal the feeble growth underneath.

- Plants that struggle for space -- a plant pushing through a crack in the pavement; a tree that grew too close to a building.

B. Compare Plants and People

1. Most texts discuss humans' basic needs of food, shelter, and clothing. Compare these with plants' needs and then consider plants' and humans' needs for space.

a. Talk about -- or observe -- examples of crowding: a traffic jam, or a long line of people in a store.

b. Use the sample lesson on crowding (Handbook Part III, Lesson 4).

c. Questions to talk about:

- How do people feel when they're crowded?

- Do people need space, too?

2. By grades 2 or 3, you can lead into textbook accounts of crowded conditions. For example, the SRA level 3 text *Cities* contains a lesson titled "Calcutta: A City With Too Many People."

Have the class consider what problems there could be over food, water, and shelter.

3. If there are examples of crowding in the classroom or school, like long lunch lines, talk about ways the situation could be made better.

ADDITIONAL RESOURCES

Picture Book

Little House. Virginia Lee Burton. Boston: Houghton-Mifflin, 1942. The crowding of city as compared to country.

Teacher References

A Curriculum Activities Guide to Population and Environmental Studies. Institute for Environmental Education, 8911 Euclid Avenue, Cleveland Heights, Ohio 44106.

Teacher's Guide for Population and the American Future. Population Reference Bureau, 1775 Massachusetts Avenue, N.W., Washington, D.C. 20036, 1973.

Sampling Button Populations: An Investigation into Statistics in the Classroom. Environmental Science Center. National Wildlife Federation, Educational Servicing, 1412 16th Street, N.W., Washington, D.C. 20036.

"Population Growth and the Six-Year-Old." Haig A. Rushdoony. *Journal of Geography,* September, 1968.

PEOPLE AND LAND: HOW ARE WE PARTS OF THE SYSTEM?

GOAL

To understand that modern technology gives humans more and more control over the natural environment, and also greater responsibility for protecting that environment.

OBJECTIVES

On the basis of lessons focusing on the concept, students will

1. give examples of ways tools allow people to change the natural environment;

2. observe and report on environmental changes in the local community;

3. demonstrate self-awareness by stating their own feelings about how the local community is changing;

4. give examples of ways the use of tools can harm air, land and water;

5. demonstrate concern for the natural environment by suggesting ways local surroundings can be improved;

6. recognize that people have responsibility to protect the natural environment.

A. Primitive Tribes and Early Humans Used Simple Tools

1. Using pictures (and your text), ask the class:

   a. How do tools help people meet their needs? Or, how would people acquire food, clothing, shelter before they had tools?

   b. Do these tools change the land?

   Once farming is involved, the changes will be more evident. Children will observe that the soil is turned over, rocks and plants removed, new plants cultivated and protected.

2. Did farm animals help? Were they used as tools? How?

B. Modern Tools Enable Humans to Make Greater Changes

1. On a field trip: Observe a construction site and ask volunteers to point out ways that different tools change the environment -- bulldozers, jack hammers, steam shovels, etc.

   A good source of construction pictures is the children's book *Bam! Zam! Boom!* by Eve Merriam (Walker Publishing Co., 1972).

2. Obtain pictures of your community as it looked in the past -- 50 to 100 years ago (the local historical society should have plenty to choose from).

   a. Compare these with other photos taken recently. (Try the Chamber of Commerce; or take the class on a photo-taking trip of your own.)

   b. Make lists of how tools were used to change the natural environment: buildings, roads and streets, parking lots, shopping plazas, etc.

   c. Can the class find anything in today's pictures that looks similar to the past? (some buildings; perhaps parks; natural features like hills or rivers)

3. Use pictures of modern farms to show ways modern technology allows farmers to make greater changes.

4. Evaluate changes made by tools

   a. Ask the class to find changes that make life better or more convenient (e.g., highways for easier travel; stores for convenience).

   b. Are there changes that don't make things better?

      - evidence of air or water pollution

      - crowding

      - perhaps fewer trees, parks, open spaces

5. Have the class consider how the community could be made better if we planned better.

   a. You might make this more concrete by talking first about how your classroom or school was planned. Consider, too, any plans you have for changing the room or any plans that exist for school remodeling.

   b. The school has changed as the community grew. See if the children can sense that many changes in the natural environment also came about because there were more people than in the past.

   c. Talk about the children's rooms at home as spaces they can plan. What would they like to do to make their rooms more pleasant?

   d. Now deal with the question of how the community can be made more pleasant. Would more trees help? Or parks? What about playgrounds or cleaner water?

      Encourage children to draw pictures of how they would like their community or neighborhood to look.

C. Machinery and Waste Products -- Sources of Pollution

1. How machines work -- remind the class of some of their systems lessons. Show pictures (or models) of machines that show different parts functioning.

   a. Ask if anyone can describe some of the working parts that make an automobile a system. (wheels, engine, starter, brakes, battery, etc.)

b. What has to be added to make the automobile run? (fuel -- or a source of energy) Do all machines need some source of energy?

Consider machines, tools, and appliances at home. What do they use for energy?

2. Point out that whenever fuel is used, there are waste products -- smoke, gasses, soot, etc. Even electricity, which appears so clean, requires energy to be produced and creates pollution.

a. Identify visible waste products in the community or neighborhood. (smoke from factories, incinerators, furnaces, vehicle exhausts)

b. You can demonstrate vehicle wastes by holding a cloth over the exhaust pipe of a running automobile for a few seconds. Warn the children never to try this themselves.

3. Use text, pictures, or audio-visual materials to identify various examples of pollution. Make sure land is included as well as water and air.

A good series of four color filmstrips, emphasizing how humans' use of machines alters the environment is *Man-Made World* (International Film Bureau, 332 So. Michigan Avenue, Chicago, Illinois 60604).

4. The class by now can consider this question: As more people live in one place, why are there more waste products?

Compare pictures of a farm, a village, a suburb, a city. Which uses more machines? Which will produce more wastes?

D. Helping the Systems That Make up the Community

1. Go back to the photographs of the community.

Or use a large wall map that shows parks and other features or else a large area map.

a. Ask the class to make a list of things made by humans. (buildings, roads, etc.)

b. Make another list of things in the natural environment: trees, parks, water, grass, etc. Be sure to include air.

c. Ask if we depend on all these things -- things in nature as well as human-made things.

2. Questions to talk over:

   - How is this community a system?

   - What are its parts (on the list -- plus people and animals)?

   - What can go wrong with the system? (Recall the wastes from machines.)

   - Do we have to be careful to keep the whole community system in good order?

3. What can we do about parts of the system that aren't working too well?

   a. Taking care of the land -- what can children do?

   b. Taking care of the water -- children can consider ways to conserve water in the classroom and at home.

   c. You might want to get into the issue of noise pollution here, too.

   d. What about air pollution?

      Consider where air pollution goes. The students can grasp the idea that their community system connects up with all others. Problems in one, like air pollution, spread to others.

      One warning, though: the problem of air pollution is farther removed from children's control than noise, land, or water pollution. Things like turning off lights help, but it may be more effective to go back to the idea of how we can plan our community better.

      Many social studies texts will deal with the role of the government in planning a healthier community.

      You can talk about plans people can make or some proposals that are being made locally. You could help the students write a letter to appropriate government representatives about changes that could be made (such as improving bus service so there will be less automobile use).

4. For reinforcement, two good books for children are: Bill Peet, *The Wump World* (Houghton-Mifflin), Thomas B. Perrara and W. Orlowsky, *Who Will Clean the Air?* (Coward Publishing).

ADDITIONAL RESOURCES

Picture Books

A Clearing in the Forest. Carol and Donald Carrick. New York: Dial Press, 1970. A man builds a house in the forest and the animals attempt to make him move away. The man and the animals make a truce when the animals realize he respects the land.

The Lorax. Dr. Seuss. New York: Random House, 1971. A beautiful natural world is ruined by the ambition of an unthinking, money-made creature.

The Mountain. Peter Parnall. Garden City, N.Y.: Doubleday, 1971. An unblemished mountain is discovered by a man who covers it with roads, picnic benches, litter, etc., and destroys the natural beauty.

Fiction

Annie and the Old One. Miska Miles. Boston: Little, Brown & Co., 1971. The closeness of Navajo Indians to the earth and nature.

Last Free Bird. A.H. Stone. Englewood Cliffs, N.J.: Prentice-Hall, 1967. The pollution of air, water, and land by man reduces the bird world to one last free bird.

Teacher References

A Chart for the Development of Basic Conservation Concepts in the Elementary Grades. Ohio Forestry Association, Southern Hotel, Columbus, Ohio.

Environmental Education Exercises: Elementary, 1-3. Environmental Education Department, Paris, Kentucky 40361.

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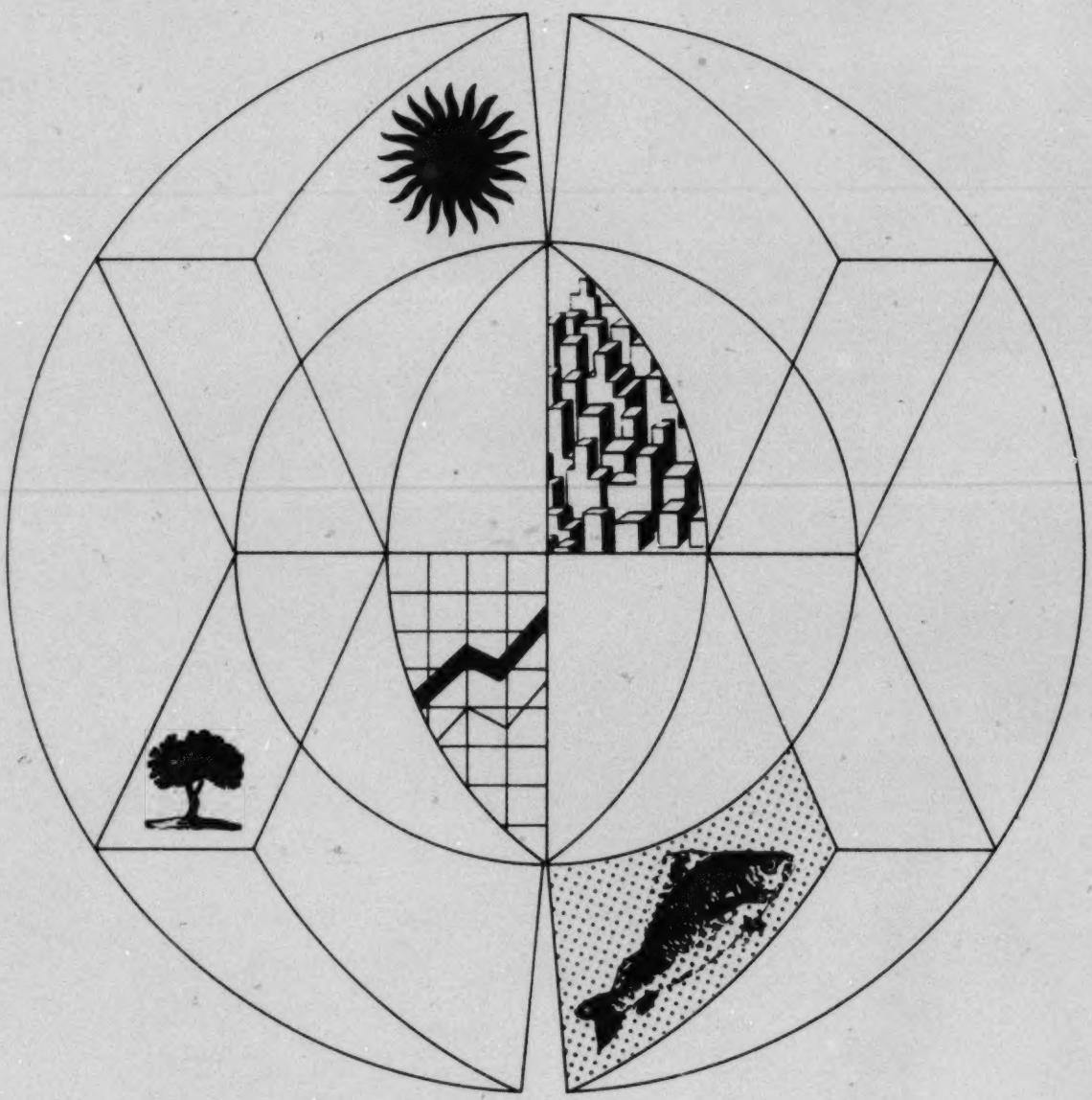
Part A
K-3 Handbook



Environmental Education
Interdependence: A Concept Approach

CENTER FOR GLOBAL PERSPECTIVES

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ENVIRONMENTAL EDUCATION

INTERDEPENDENCE: A CONCEPT APPROACH

HANDBOOK PRIMARY GRADES K-3

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ENVIRONMENTAL EDUCATION

INTERDEPENDENCE: A CONCEPT APPROACH

HANDBOOK PRIMARY GRADES K-3

INTRODUCTION

To help children understand environmental issues through the concept of interdependence, the teacher should first have the concept clearly defined and set in his or her own mind. An abstraction like the mutual dependence of interconnected, interrelated, or intertwining parts may help the teacher, but it is a specific system -- a group of things or parts that make a whole -- that can be made most concrete and meaningful to children. Using familiar toys (e.g. puzzles or play cars) as vivid examples of systems, young children can easily see that it is the combination of parts which form the whole. With the teacher's guidance, they can expand this simple definition of parts forming a whole to include three component understandings:

1. the parts of the whole work together and depend on each other *(mutual dependence)*;

2. the proper working of the whole system depends on the *well-being* of each of its parts (if one part is not working, the functioning of the whole is affected);

3. *equal care* must be taken to maintain the well-being of all the parts (with corrections made to fix faulty parts) if the whole is to work as an efficient system.

The teacher and students will find it easier to distinguish systems from nonsystems if they keep this key attribute in mind: the parts together contribute to or perform a function that could not be performed by the parts separately; in other words, the whole is greater than the sum of its parts. The teacher should use this key to determine what things will serve as good examples of systems and will clarify the definition(s) for children.

The series of lessons that follows attempts to lead toward a conceptual framework for interdependence by building on the core definition of a system and extending this foundation (to include the three components as well as the critical attribute) only as the children show they are ready to expand the definition. From my own experience as a primary teacher, I know how important it is to ensure early success (and consequent continuing interest) by first introducing the concept in an easy and exciting way, without new or unfamiliar content. In other words, first

teach about systems using concrete known objects, so student energy can be focused on the concept itself ("Why is the toy car you put together today a system?") rather than on confusing less familiar content ("What are the systems in your community environment?"). This is not to say that such content areas as the study of the community should not be combined with the study of interdependence and systems. Rather, examining the interdependent systems of the community environment should come later, and only after children have first had ample opportunity to experience examples of the concept at first-hand. Then, and only then, can the concept of systems serve as a meaningful overlay on other primary content areas, starting with the self, the family, and then the community.

This handbook provides an introductory section and sample lessons in each of these K-3 typical social studies areas. Part I -- *What is a System?* introduces the systems concepts using toys, objects, and machines. Part II -- *Am I a System?* overlays the concept, in terms of body systems and subsystems, on the child's study of self. Part III -- *Systems are Everyone Everywhere!* starts with the family, to show how groups of people work as systems, and moves toward more complex understandings of community and environmental systems. At this early level we begin to deal with the twin concerns of population and pollution as they relate to systems.

Directed lessons, as well as optional follow-up activities are suggested, with alternative plans for incorporating the learnings as center or choice activities included. Also suggested are ways to extend or enrich the lesson, and to lower the level of difficulty so adjustments can be made for individualization of learning.

The introductory lessons in Part I are given in detail since the initial concept building experiences are crucial to children's understanding of and ability to apply the learning. The lessons in Parts II and III, in which the concept is used as a lens through which children look at other content areas, are merely sketched, as examples of how the concept can be inserted into existing curriculum areas. These will spark many of your (and the children's) own ideas for overlaying the interdependence concept on individual curriculum needs and interests.

SYSTEMS ARE ALL AROUND ME

Lessons for Grades K-3

PART I -- WHAT IS A SYSTEM?

LESSON 1: PUZZLES ARE SYSTEMS

GOAL

To introduce as simply as possible the basic idea of parts fitting together to make a whole or a system, using easy jigsaw puzzles (good for grades K-1 if large-piece picture puzzles are used so that each piece fitting together to make a whole is as obvious as the gap left by a missing or mismatched piece(s) of the puzzle system. This is not so apparent in small-piece puzzles).

OBJECTIVE

Given two sets of puzzle pieces (one set in which all the pieces fit as a whole and the other set with missing or mismatched pieces), the student will identify which set fits together to make a whole system and which does not, and will tell why; the students will state in own words what makes one a system and the other not.

MATERIALS

Variety of easy picture puzzles (can be ready-made ones or simple pictures or picture cards cut up into puzzles by the teacher; can even be squares of colored paper cut up into puzzle pieces for older students, grades 2-3).

Paper bags or some other container (envelopes, boxes, boards) for easy distribution of each matched and mismatched set of pieces.

PROCEDURE

1. Give each child (or each set of partners, if you prefer children working in pairs of if you are short on puzzles) two bags of puzzle pieces, with Bag 1 containing a matched puzzle and Bag 2 containing a mismatched or incomplete puzzle.

2. Tell each child to try to make a whole puzzle from each separate bag (to avoid mixing pieces between the two bags, and resulting confusion and frustration, you might color code each puzzle's pieces or hand out only one bag at a time).

3. Have each child identify which bag or which set of puzzle pieces made a whole puzzle and which did not.

4. Encourage each child to tell why one set of pieces fit into a whole puzzle and why the other did not, reinforcing such words as *parts, whole, fit together, connected* or other words which indicate understanding for your age of students. These will become the basic vocabulary of systems learning, while the growing verbalization of what happened and why (a form of debriefing at the primary level) will continue to be the most important part of each lesson as children come together to share experiences and feelings, to discuss insights, and to learn and use new vocabulary labels.

5. Inform the children that each of their completed puzzles is a "system," explaining that this is so because the parts fit together or are connected together as a whole. Make sure you also indicate that their incomplete puzzles are not systems because they do not fit together as a whole. With older students, you might be able to explain that one missing or mismatched piece affects the whole puzzle, and that care of each piece of the puzzle is important to the whole (this last being a good way to lead to more careful cleanup of puzzles). Although it is probably too early to introduce any one or all of these expanded definitions of systems, keep them in mind and apply them as they fit. Perhaps you can use them with individual students who are thinking way ahead of the others or by building on a child's relevant comment (for example, if some child complains about puzzle pieces always being lost or mixed-up as in Bag 2, it might be a good time to discuss how one missing part can ruin the whole and why it is so important to care for each piece when using or putting away puzzles).

6. Use this idea of caring for each part as you tell children to clean up their puzzles carefully. Bag 1's completed puzzle can either be returned to the bag (and children who can write might print SYSTEM in huge letters on the bag as another way to reinforce learning of this new word) or the completed puzzles can be moved to a table or bulletin board for display under the heading SYSTEMS. Bag 2's pieces can simply be returned to the bag with a quick review of why this bag won't be labeled SYSTEM.

OPTIONAL FOLLOW-UP ACTIVITY

Appoint one or more able students as "Puzzle Systems Monitors" to arrange the Systems display of all completed puzzles and/or, as a sorting task, to correct and complete all Bag 2's puzzles.

ALTERNATIVE LEARNING ACTIVITY

For a center: This same lesson can be easily modified for use at a center rather than as a directed lesson, depending on your particular classroom needs. A "Puzzle Center" could be set up with bags or boxes

of both complete and incomplete puzzles. Children could either label complete puzzles as SYSTEMS or could in some way categorize (on a divided table or separate tables) those that are SYSTEMS and those that are NOT SYSTEMS. The teacher could build meaning on these labels as he or she monitored the center and asked children to tell what makes a puzzle a system. Also, the importance of the care of each part to the well-being of the whole could be emphasized in the kind of cleanup procedures required at the center. These not only teach more about systems but also help the teacher by keeping track of puzzle pieces.

LESSON 2: OBJECTS CAN BE SYSTEMS

GOAL

To provide a concrete example of a functioning system -- a retractable ballpoint pen -- in order to extend the definition of a system and subsystems.

OBJECTIVE

Given pieces of a retractable ballpoint pen, the student will tell what he had to do to make the pen a functioning system.

MATERIALS

A retractable ballpoint pen for each learner (or one pen for every two students if short on supplies)

PROCEDURE

1. Distribute the pieces of the pens so that some students have all the pieces needed, some have too many, some too few, and some have faulty parts.

2. Tell the children to combine the pieces they have so that all the parts work together as a whole or system -- in this case, a pen system which writes (functions). Depending on the level of the student, the teacher might label the parts of the pen and show how it's put together before expecting younger children to try to assemble a pen.

3. When some can't get their pens to work, ask why, and reinforce appropriate systems vocabulary in their explanations. Have them see if they can correct the problem by checking with others who have completed a working pen as a model and/or by trading with others who may have the extra parts needed (all the necessary pieces for each pen to be completed are somewhere in the room).

4. When most or all have assembled a working pen, discuss (debrief) the following questions: Why is the pen a system? If the working pen is a system and the separate pieces were not, what is a system? What function do the parts perform together that could not be done by the parts separately? How do the parts work together? Which parts depend on each other? Are there any smaller (sub)systems in the pen? What happens if one part is missing or broken? (Most vivid answers here will come from those who received incomplete or faulty parts.) Why is it important to care for all the parts of the pen?

5. Have each child immediately apply his growing knowledge of systems by naming other functioning systems that they see in the classroom (e.g. scissors, stapler, pencil sharpener, etc.) or use at home. Be sure to push them to identify some of the parts, how they work and depend on each other, and what function they perform together. (If someone mentions systems other than things or objects, such as people or place systems, acknowledge this beginning application of systems to other areas of their lives, saying that it's another kind of system to be studied later.)

OPTIONAL FOLLOW-UP ACTIVITIES

1. Any simple functioning system, like a flashlight, can be substituted for the pen (depending on the level and interests of your students) or the flashlight might be used as a follow-up activity to provide another concrete example of a functioning system.

2. As further application to increase awareness of functioning systems in their environment, have children find and list examples of mechanical systems in their homes, or cut out and bring pictures of systems from magazines or newspapers.

ALTERNATIVE LEARNING ACTIVITIES

1. For lowering the level of difficulty: Children (K-1) might feel more successful if each received all the parts of a pen rather than needing to trade or exchange parts; in fact, for very young or low level students receiving a working pen first to take apart and then put back together might be more successful. Later, a part might be taken away by the teacher, with each child observing, and with discussion of what happens to the pen system when a part is missing or not cared for properly.

2. For use at a center: This lesson is easily adapted to a center or choice table. Parts of working systems like a pen or flashlight can be placed on a table for children to put together and take apart as a good manipulative activity as well as an introduction to systems (call it the "Fix It" center or "Repair It" center, focusing on the care and correction of systems and finding and keeping all parts together in a system). The teacher can ask the kind of debriefing questions suggested in procedural steps 4 and 5 as he or she monitors the center in order to aid understanding and application as well as building vocabulary. Another center might be filled with both broken and working objects, for children to sort into boxes labeled SYSTEMS and NOT SYSTEMS.

LESSON 3: TOYS ARE SYSTEMS (CAN YOU MAKE YOUR OWN TOY SYSTEM?)

GOAL

To encourage creative problem-solving as children manipulate random parts to discover how they might be combined into a moving, functioning system -- a spool toy car that goes! (This lesson can be used as a vivid first lesson for older students (2nd-3rd) to lead to a definition of systems.)

OBJECTIVE

Given several discrete parts (wooden spool, dowel, tack and rubber band), the student will combine the parts into a moving system that travels across the floor and will label the particular relationships between the parts which are needed for the system to work properly.

MATERIALS

A wooden spool for each student or two (Students can be asked to bring spools from home; if empty spools are not available, the thread can be left on and protected with masking tape.)

A thumb tack for each spool

A 3-inch long rubber band for each spool

A piece of thin wood doweling that could fit through the spool or a wooden toothpick or stick from a cotton swab

A paper bag or envelope for each set of materials (optional for ease of distribution)

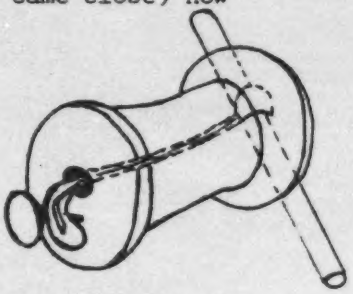
PROCEDURE

1. Tell the class that each of them will try to make a spool toy that moves across the floor (function) out of the four parts they will find in their bags of envelopes. Show them the spool, dowel, tack, and rubber band. Tell them it is their task to combine the parts into a system that moves across the floor. Be sure to warn them that it is a difficult task (in fact, few children discover the system on their own without teacher instructions, although some will come close) but that you are asking them to try for a designated time period without coming to the teacher with questions. To lessen anxiety and frustration, you might tell them they can come to a designated corner in the room for help when you give a signal or can choose to work longer on their own.

2. Give each child (or partners) a set of the four objects and a space on the floor to work. Let the children work long enough to try a variety of combinations before signaling for those who are frustrated to join you for help. Let those who want to experiment longer on their own do so.

3. Gather the whole class together after a reasonable length of time (since some children will pursue it forever!). Have various individuals share at least one of the ways they tried to combine the parts. Let them show how well it worked (or didn't work) as a system that performs the function of moving across the floor. Reinforce their creative efforts to balance the frustration of a difficult task.

4. Demonstrate (or have a student who got it right or came close) how the actual spool toy system works:



   - Put rubber band through spool lengthwise.
   - Tack rubber band to one end of spool.
   - Put dowel through rubber band at other end.
   - Wind until tight.
   - Set it on the floor and watch it go! (They love this and their previous frustration is forgotten as they ask to redo their own toy.)

5. Let each child try to make his own spool toy function, now that the system is known. Emphasize the particular relationship between the parts as you dismiss the children to try it again.

6. Discuss with the group the dependence of one part on another (this might be a good place to introduce the term *interdependence*) and have them label the relationships necessary to make the spool toy system move. Ask how one part in the wrong place affected the whole system (this will be especially obvious to those who originally came very close but missed just one connection). Discuss the importance of the system connections so that each part contributed to a function that couldn't be performed by any separate part alone.

OPTIONAL FOLLOW-UP ACTIVITIES

Gather other random items into bags or envelopes (or fill a table called the "Systems Discovery Center" with odd items) and let children experiment in trying to combine them into other moving or functioning systems. Discuss how they combined the parts to depend on each other, and whether or not the system worked as a whole and had a function.

LESSON 4: MACHINES ARE SYSTEMS

GOAL

To reinforce previous learning with a change-of-pace activity in which children "move to learn" as they become parts of machines by role-playing mechanical systems, emphasizing the connections (interdependence) of each part and the implications for each individual member of the system.

OBJECTIVE

By role-playing familiar machines, the student will move to show a connection or relationship to another part of the machine (as another kind of evidence of understanding of interdependent parts) and will tell how his or her part was important to the rest of the system.

MATERIALS

An open space where children have room to move freely, such as a rug area or space cleared of desks

PROCEDURE

1. To build transfer from previous lessons, tell children that they are going to be or role-play parts of systems -- machine systems -- and that their job is to fit and move together with other parts of the system. The idea of showing connections is as basic to a drama machine (a theatre game technique) as it is to real machines.

2. Start with an easy or familiar machine with which children have had experience or one they can observe in the classroom as a model during this initial role-play. Discuss and list the parts of the selected machine (e.g. pencil sharpener, record player, etc.) and identify their connections.

3. Have each child move out to a space in the room and be any one of the parts by making a particular motion of his or her choice (allow for creative interpretation of the part's movement). Point out that until they become connected, they are not a functioning machine or system.

4. Now call for a volunteer to come to the center of the room to continue his or her movement (it is important that this first and central member be making one continuous or repeating motion which can be sustained while others connect). Then have another join in, attaching or connecting to the first so that both are moving

together in a related way even though their motions may be very different. One by one continue to call on more members until the machine is a complete system resembling the selected model. At this point, the members of the machine can add sounds, if appropriate to the machine being role-played.

5. Bring the remainder of the class together as an audience for this first role-played machine. Have them watch the machine start up again, and evaulate the machine in terms of what they have learned about systems. Direct the machine to speed up or slow down, and have the class discuss how well the system worked. Direct one part of the machine to change its motion or break down, and again discuss what happened to the system. Have the machine repair itself, and then give the direction to stop. Have the audience comment on whether the machine stops together as well as works together. By this time members of the machine will be tired and can comment (even show) what happens when machine parts wear out. They also might discuss the care needed to maintain a working system.

6. Before letting children try other machines, emphasize these basics of both drama machines and real machines:

   - Each part does only one thing over and over, with the same motion in the same position at the same speed (unless the machine is directed to change speeds);

   - Each part is in some way attached or connected to another part, either by touching, overlapping, or interwining, or in some other way moving together;

   - If something happens to one part (breaking down or wearing out), all the other parts are affected and show the change.

7. Now let the children be more creative by choosing or designing their own machines, either improvising parts of known machines or inventing imaginary machines (as long as the parts they play are connected and work together as a system). It's still best to have one person start an action before another joins, so that the connections are more clearly visible than when several people join in at the same time (as children will tend to do when role-playing machines on their own). Make sure each time to encourage the audience members to discuss and evaluate each machine, as in step 5.

8. When the children have the idea, additional fun can be had by assigning some of your students as directors. They can suggest the kind of machine to be role-played and can call on volunteers to join the machine. They also can direct the machine when to make a sound, change speeds, or break down. It is especially popular with young children to appoint a mechanic who tries to correct or repair the machine after a breakdown. The audience

can help the mechanic by identifying how each part was originally connected.

9. Be sure to debrief each member of each machine, in addition to audience discussion, by asking: How did it feel to be part of a system? How important was your part in the machine? (stressing here the interdependence and importance of each part) What happened to your part when another part changed its motion or speed? Why was it important to have a mechanic care for each part of the machine and to correct any problems in its functioning?

OPTIONAL FOLLOW-UP ACTIVITIES

1. Let children choose their best functioning machines to show to other classes, to see if they can guess the kind of machine and its function.

2. Have children play a version of the "Liars' Club" game in which the teacher and/or children bring from home an unusual object, toy, or machine system (e.g. gadgets, appliances) for which the function is not readily known by all or most of the class and has to be guessed from information given, some truthful and some lies. To play this game, *one* child knows or is told the true function of the object and three other children are selected to make up or "lie" about its function. Audience members (rest of the class) do not know which is which. They see the object and hear the panel of four tell their function stories (one truth, three lies). The audience then votes for what it thinks is the true function on the basis of what seems most probable. The truth-teller then steps forward and explains the function in terms of how the parts work together and depend on each other as a whole to perform that function. This is also good activity to share with another class.

Now that children have worked with a variety of simple machines, they are ready to apply their knowledge and expand their examples of systems beyond things. Some children may already have discovered that parts of their bodies are a system, if not suggest it yourself because the study of self and one's own body is a good primary unit for inserting in or overlaying on systems learning.

PART II -- I AM A SYSTEM:

THE BODY SYSTEM AND INTERDEPENDENT SUBSYSTEMS

LESSON 1: WHAT'S IN A THUMB?

GOAL

To demonstrate the interdependence of body parts -- the thumb to the rest of the hand and to the total functioning of the body, including emotions -- in a vivid and fun way.

OBJECTIVE

Having thumb on one hand taped down so it can't be moved, the student will attempt ordinary classroom tasks and comment on experiences as well as feelings when a body part is not working.

MATERIALS

Masking tape

PROCEDURE

1. Have students work in pairs to tape one of each other's thumbs. (The one doing the taping second will already begin to experience how difficult it is to tape the other's thumb.)

2. When thumbs are taped, direct children to try a variety of familiar classroom tasks, such as writing their names, coloring pictures, sharpening pencils, opening glue bottles, etc.

3. Discuss how they felt when one body part was not working, and encourage comments on both physical and emotional feelings and their interdependence. Ask what activities were difficult to do and why, reinforcing the systems vocabulary learned earlier. If appropriate, show a picture of the inside of the thumb and hand (even whole body) and identify the parts and their connections. Apply this taped thumb experience to their own experiences with broken or sprained fingers (or arms or legs). Ask what happens when they break a bone or pull a muscle. Why does the doctor set the bone (to regrow/rejoin the connection) or ask them to rest the muscle (to strengthen the connection)? How does this affect the rest of the system?

OPTIONAL FOLLOW-UP ACTIVITIES

1. Try this same lesson except with an arm taped or tied down, or with a leg taped or tied to a yardstick (or have the children run a one-legged race), and discuss the parts (physiology) and connections (interdependence) of these other body parts.

2. Have the children sing and point to the connected bones in the song, "D'em Bones" ("The shin bone's connected to the knee bone, the knee bone's connected to the thigh bone, the thigh bone's connected to the hip bone,...").

ALTERNATIVE LEARNING ACTIVITIES

For a center: Have children put together simple paper puppets by cutting out patterned body parts and connecting them with paper fasteners or brads at the joints (a skeleton puppet would be a fun and vivid model of the main parts of the skeletal system).

LESSON 2: THE SENSES -- WHEN DO I EAT WITH MY NOSE AND EYES?

GOAL

To demonstrate vividly (and deliciously) the interdependence of the senses, especially sight, smell, and taste systems.

OBJECTIVE

Given a variety of food samples, the student (blindfolded) will try to identify selected foods by smelling without tasting and by tasting without smelling, to experience the interdependence of sense systems.

MATERIALS

Samples of food which are difficult to guess without multi-senses (e.g. apple, pear, onion, marshmallow creme, mint jelly, cranberry sauce, chocolate syrup, etc.)

1 blindfold or eye mask per child (optional)

1 tongue depressor (plastic spoon) per student

paper cups

PROCEDURE

1. Arrange the children into pairs. In each pair, one child (the judge) will be tested by his/her partner (the testor).

2. Instruct the testors to blindfold their judges. Then pass out paper cups containing the individual samples. Be sure each pair of students receive identical sets of cups (each cup in the set is numbered so that corresponding cups contain the same sample.)

3. Silently show the testors one of the numbers corresponding to a cup in their set. They then hold the appropriate cup under the nose of their blindfolded judges. After they've had a few seconds to sniff, the judges whisper into their testor's ear what they think the smell is. Their partner tells them only if they are right or wrong.

4. Test the remaining samples in the same fashion.

5. Now tell the children that they are going to taste some foods without using smell (or sight, so keep their blindfolds on). Instruct them to hold their noses while they open their mouths. Their partners will place a spot of the sample (after you show the number) on their tongue with the plastic spoon or tongue depressor.

After the judges have had a chance to thoroughly taste the sample, let them whisper to their testors what they think the sample is.

6. Have the children remove their blindfolds and resample the same foods, so they can immediately experience the difference when all senses are working. Or, have them keep their eyes covered while resampling to find out how their guesses improve with smell and taste working together as interdependent systems.

7. Now have the partners change roles. Once the judges are blindfolded, distribute a new set of samples to the testors. Repeat steps 3-6.

8. When the activity is finished, have the children discuss what happened when their various senses were not applied, and how foods improve when sense systems are functioning interdependently. Ask how the different sense systems, especially smell and taste, are connected and dependent on each other (include as much of the physiology as appropriate, with pictures to help). Have the children apply these understandings to what happens to their food appreciation when they have a cold, allergy, sore throat, or burned tongue. Discuss why it is important to care for each separate sense organ if the whole sensory system is to function properly.

OPTIONAL FOLLOW-UP ACTIVITIES

To introduce the other sense systems and their interdependence, make touch and/or sound bags in which children have to identify the objects inside without opening the bag.

LESSON 3: WHY AM I OUT OF BREATH?

GOAL

To have children experience directly the interdependence of other body systems, such as circulatory and respiratory, after varying amounts of physical exertion.

OBJECTIVE

After engaging in different kinds of both vigorous and non-vigorous activities, the student will compare the changes in his or her heart beat, pulse rate, blood pressure, respiration rate, perspiration, etc.

MATERIALS

Variety of play equipment (jump ropes, balls, bats, etc.)

Watch or clock with second hand

Stethoscope (optional)

Blood pressure testing equipment called a sphygmomanometer (optional)

PROCEDURE

1. Have each student choose some vigorous physical activity (jogging, jumping rope, playing ball, etc.) to engage in for 3-5 minutes (if all students choose the same activity, comparisons can be made in terms of how different children's systems reacted; if each student chooses a different activity, comparisons can be made in terms of the effects of differing activities on body systems).

2. Either have each student make his or her own comments of changes felt after exercising, or have children observe each other during exercise. (If the school nurse is available, or the equipment for testing heart beat and blood pressure can be borrowed, take advantage of the fact that children love to have their blood pressure and heart beat checked, as well as their pulse rates measured with a watch or clock with a second hand.) Depending on the appropriateness for your students, and what is available in your health or body unit, explain the physiology of the related systems and how they function interdependently during exercise; children can learn to identify the basic parts and functions of their body systems and use these new terms to describe reactions during and after exercise or exertion.

3. Then have the children engage in less vigorous activities (resting, reading a book, writing or drawing, etc.) and have them note the differences in body changes and reactions, as compared to more vigorous exercise. Discuss how the systems work together to adjust the body to different activities and how care of each helps maintain the whole body system in proper working order.

OPTIONAL FOLLOW-UP ACTIVITIES

To extend and enrich learning: After introducing children to their body systems through the kinds of vivid activities and games suggested, you may choose to develop a more detailed and systematic body or health unit by having children study each system, starting with the skeletal system as a framework, and looking at each system as a subsystem in terms of: parts, connections, functions, care and maintenance, and interdependence -- within and between subsystems as realted to the total functioning of the body system.

After applying the systems-concept-lens to look at the systems or subsystems within their own bodies, children should now be ready to expand their definitions and examples of systems to include more complex people and place systems in their community environments. They will see that people can be parts of systems too, and that sites in their environment are also organized into systems. It is important to start with the family and home environment as familiar examples of people and place systems. Then you can explore the more complex systems in the wider environment as well as the relationship of systems to population and pollution pressures.

PART III -- SYSTEMS ARE EVERYONE EVERYWHERE!!

LESSON 1: HOW MANY SYSTEMS DO I BELONG TO RIGHT NOW?

GOAL

To help children understand that they and other people are important parts of systems and that they belong to many people systems, through the use of familiar systems in which all or most of the members are known.

OBJECTIVE

Given the names of familiar people systems, the student will stand up each time he or she is a member of that system, to realize how many different people systems depend on his/her membership.

MATERIALS

Sentence strips or large index cards on which to write names of various people systems (optional)

PROCEDURE

1. Hold up a card giving the name of a particular people system (e.g. a family, a classroom, a Little League team, a Boy or Girl Scout troop, etc.) and ask those children who are parts or members of that system to stand. Emphasize the idea that people are parts of systems too, and call on selected individuals to tell just what part they play in each particular system. Have the children identify what parts or functions are played by other people in the system (all or most members of these familiar systems should be known by the children). Ask the children to tell what happens when they don't do their part in a particular system and how that affects other people in the system who are depending on each other.

2. Ask the children to name other people systems to which they belong, not included in the teacher's cards. Ask specifically for systems in which people are important parts.

OPTIONAL FOLLOW-UP ACTIVITIES

1. Children can be asked to look through magazines and newspapers to cut out pictures of other people systems (e.g. an office staff, an orchestra, etc.), for display on a bulletin board or at a center.

2. During story time, the teacher can select books which give examples of people systems (books about people in other cultures can begin to build cross-cultural understanding) and ask children to raise their hands whenever they hear or see something in the book about a system of people, encouraging them to identify the system and its parts of function.

ALTERNATIVE LEARNING ACTIVITY

To extend learning: After children have identified those people systems which they are familiar with as members, expand their thinking to include the less familiar and more complex systems they depend on (as consumer members) for their food, clothing, transportation, etc. Use vivid examples from the food items in their lunch boxes, the clothes on their backs, or the way they got to school that day, to trace all the systems they depended on in order to get to and from school fed and clothed. Take these examples as far back to the originating system as children can understand, explaining why many of the members of these more complex and distant systems are unknown.

LESSON 2: HOW DOES MY FAMILY WORK TOGETHER AS A SYSTEM?

GOAL

To overlay concepts of systems/interdependence on the typical primary study of the family.

OBJECTIVE

Through role-playing family activities and special events (e.g. party, picnic, trip, etc.), the student will identify family roles and their interdependence in functioning as a family unit.

MATERIALS

Open space somewhere in classroom for role-playing

Index cards for writing individual family roles to be assigned

PROCEDURE

1. Decide on a particular family activity or event, preferably one which the whole family does together (e.g. getting ready for a family trip or celebrating a holiday, perhaps even including extended family members).

2. Have the class agree on a specific role to be played by each family member (with the family as big as the class decides and including extended family members as appropriate), with the teacher listing each family member's role on a separate card (e.g. Mother -- packs suitcases; Father -- has car checked and loads luggage on car; Son -- takes dog care instructions and food to neighbors; etc.).

3. Hand out the cards to volunteers who wish to role-play, instructing them to make their roles as obvious as possible and also to make obvious the connections (or misconnections) between their roles, almost as in the drama machines tried earlier. To ensure successful role-play, the teacher can offer suggestions to get things started: You might suggest that they first role-play a bad version of the system in which the family members are not connected (e.g. Father loads the luggage without first checking to see if Mother has finished packing them, and has to unload them for further packing) and then correct the system to show a well-functioning family system in which each member performs his role carefully. (This role-playing the bad or wrong way first and then correcting it to show a good way at the end leaves the students with a positive model and is a helpful technique to make role-playing more structured and successful.)

4. Let the role-play volunteers practice how they will organize their family and how they will make their roles obvious with actions, words, and even props. If you have instructed them to show both the bad and good ways, let them practice both versions so that the differences in the way the faulty and then the improved family systems function are obvious.

5. Instruct the audience (rest of the class) to be looking for connections and/or misconnections in each family system's functioning, as they get ready for the event.

6. Have the audience evaluate each role-play in terms of systems vocabulary and definitions learned earlier but with emphasis on people as the important parts of the system. Did the family work together as a system? Why? Why not? What part did each member play? On whom did each member depend? What happened when one member did not do his/her part carefully?

7. Follow these same steps for successive role-plays *except* intentionally forget to pass out one of the cards of family roles the class listed for a particular event. As children role-play, have the audience try to identify what's wrong with the family system, which role is missing and how it affects the whole system as well as the success of the family event.

ALTERNATIVE LEARNING ACTIVITIES

1. If role-playing is not appropriate for your particular class, this same lesson on family systems can be handled with pictures of families engaged in different activities or events (again, pictures of families in other cultures and their activities and events can build a bridge to cross-cultural understanding). Have the children study a picture to identify how each family member is working as part of the family system. Then remove or cover one of the family members and have the children discuss how a missing member affects the rest of the family as well as the event.

2. These family lessons can be applied easily to other people systems -- such as classroom monitors, P.E. teams, a city or community. Follow the same procedures of naming the group, the event, and the roles of each member before role-playing or while looking at pictures of these other kinds of people systems.

LESSON 3: HOW DO THE MEMBERS OF PEOPLE SYSTEMS FIT TOGETHER LIKE A JIGSAW PUZZLE?

GOAL

To build transfer from earlier lessons and make vivid to children the interdependence of group members in the performance of a given function.

OBJECTIVE

Given a part of something (an object, a story, etc.), the student will fit his or her particular piece together with the pieces of other members of the group to make a whole.

MATERIALS

Puzzles, pens, flashlights, toys, etc. separated into parts

Dittoed stories cut into separate paragraphs

PROCEDURE

1. Follow the procedures of earlier lessons (Part I, Lessons 1-3) but this time the emphasis is on the group working together and sharing parts to fit together a system (rather than the original emphasis on the individual fitting together his own pieces of a system). So, instead of giving each individual all the pieces of a system to combine, give one piece to each group member. The focus thus changes to how well the members of the group fit together as a system.

2. Tell the children that each group is to make a functioning system (one group might have puzzle pieces, another pen pieces, another flashlight pieces, another toy pieces, another story paragraphs, etc.).

3. Discuss (debrief) what happens when one member (there's often a stubborn one) won't share his particular piece, or when someone (the kind that won't follow group suggestions) puts his piece in the wrong way and impairs the system, or when another (the kind who bends or breaks his or her piece while waiting) doesn't take adequate care of one of the parts. Also discuss the positive aspects of those groups that worked together well to make a functioning system with care for all parts. Ask these groups to explain how their members worked together as a system (to complete another system). Have them give examples of the interdependence between group members.

OPTIONAL FOLLOW-UP ACTIVITIES

1. As one way to apply the interdependence of people systems to other parts of the school day (e.g. language arts), use dittoed reading material, made interdependent by simply cutting up stories into paragraphs or parts. Give each member of a group only one paragraph or part to read and recall in order to teach it to other members of the group. Thus, each child gets a piece of information but it takes all the group members to put the information puzzle together, helping children to realize that none of them could know the whole without the aid of everyone else in the group, since each member had an essential contribution to make. Debriefing is important to discuss what happened when someone wouldn't share his or her information or didn't take care to learn the information well enough to teach it to the others. Also discuss the positive aspects of interdependent learning when group members shared and cared, and worked together as a whole or system. ("The Jigsaw-Puzzle Method" described here was taken from an article by Eliot Aronson, "Busing and Racial Tension: The Jigsaw Route to Learning and Liking," PSYCHOLOGY TODAY, February 1975, pp. 43-50.)

2. This same jigsaw-puzzle method in reading can be extended to writing by having children write group stories where each member of a group has to contribute a sentence or paragraph that fits together with the rest of the story as it develops.

ALTERNATIVE LEARNING ACTIVITIES

1. To raise the level of difficulty and increase the complexity: Older students might be challenged more by playing a version of "The Co-operation Game" in which each group member is given an envelope of geometric-shaped puzzle pieces. No one member is given all the pieces needed to complete his or her own puzzle square but the group together has all the necessary geometric-shaped pieces to complete a square for each of them. (To prepare, make enough squares out of the same color construction paper for the number of members in the group, cut them up into geometric-shaped pieces and randomly place the resulting pieces in one envelope for each group member.) Within a time limit and without talking, each group is to try to complete a set of squares equal to the number of members in their group. Discussion of what happens when one member won't work toward the group goal of a common set of squares is essential.

2. To raise the level of understanding of interdependence between as well as within systems: The teacher can distribute the parts of objects, puzzles or stories so that *no one group has all the parts necessary to assemble a functioning system.* Tell each group to complete a functioning system within their group. When they realize they can't, discuss what has happened in the distribution of the parts and how the problem might be corrected. Let them trade with outside groups to get the parts needed so that they may experience

the interdependence between systems. Discuss how systems depend on other systems and how their own school groups depend on other groups.

3. For a center: Set up an "Assembly Line Center" to demonstrate the efficiency of interdependent roles when one person does the same job and adds the same part to the system over and over. When papers need to be combined and stapled together or writing books need to be made, assign children to the center who will line up in assembly-line fashion and take responsibility for one repetive task. Compare the time it takes an assembly-line to complete the task as opposed to a single child.

LESSON 4: WHAT HAPPENS WHEN THE SYSTEM GETS TOO BIG AND CROWDED (AND I FEEL "SANDWICHED" IN)?

GOAL

To emphasize in a vivid way the pressures of overpopulated systems.

OBJECTIVE

After having the size of the group increased without an increase in the group's resources, the student will discuss the problems of overpopulation of a system.

MATERIALS

Selected sandwich makings

PROCEDURE

1. Assign children to groups of varying sizes, some as small as one-two and on up to large groups of eight or more.

2. Have each group stand or sit in the same size space (to begin to feel the pressures of overpopulation if assigned to a large group).

3. Distribute enough to make one sandwich (e.g. a bun, slice of meat/cheese, lettuce) to each group: giving individual members of each group responsibility for separate food items (with not enough jobs or responsibilities to go around in the larger groups, to simulate problems of unemployment at a low level).

4. Tell each group to make a sandwich and then try to reach agreement on how to divide it among all the members of their group.

5. Note comments and reactions as the different sized groups make and then divide their sandwich.

6. Share your list of their comments/reactions with the children and have them discuss (debrief) why some groups probably reacted differently than others. Discuss what happened when the group was so large that there was not enough space or jobs or food to go around. Discuss what happened to the system when people were crowded together with not enough food. What happened if one of the group members with responsibility for a food item decided not to share? What happened if the sandwich did not get divided equally?

ALTERNATIVE LEARNING ACTIVITY

If separate sandwich makings are not appropriate for your class, this lesson is just as effective using a candy bar or some other single food item (e.g. individual French rolls) which the children don't have to comgine before agreeing how to divide it equally among group members.

LESSON 5: HOW CAN OVERPOPULATED SYSTEMS BE CORRECTED OR IMPROVED?

GOAL

To teach the care and correction of systems for the well-being of all.

OBJECTIVE

In a class discussion and/or a walk or bus trip around the community, the student will identify overcrowded systems that he or she is familiar with and will discuss ways each system has been or might be cared for and corrected.

MATERIALS

A bus, if a field trip around the community is the way selected to identify overcrowded systems

PROCEDURE

1. Ask children to think of overcrowded systems in their own experience (cue: "When is the last time you had to wait in a long, slow line or crowd?") and list all examples on the board (e.g. freeway/turnpike, market line, Disneyland, etc.).

2. Have children go back over this list to discuss each example in terms of what's already been done or what they might suggest be done in the future to correct this overcrowding. More advanced students can make predictions and suggestions for future systems planning, while average students might interview their parents to find out what changes have been made to try to correct crowded systems. Example of list on board:

Crowded Systems	Present Corrections	Future Plans
freeway/turnpike	bus and carpool lanes more freeways	monorails
market	quick-check express lanes	computerized check-out

3. Take children on a walk or bus trip around the community to spot other examples of overcrowded systems. Also have them look for examples of polluted systems, often a result of overpopulation. Have them look for any corrections that have already been made in the system (e.g. a new kind of traffic signal at a busy intersection;

a new high-rise parking structure away from the central area, with a mini-bus system to get people to their destinations; litter signs, smog alerts, etc.). Those who are able can be encouraged to predict or suggest other ways these crowded or polluted systems might be better cared for and corrected.

OPTIONAL FOLLOW-UP ACTIVITY

To apply this lesson to overcrowded or polluted systems within children's own control, have your class identify and agree on overpopulated or overpolluted systems in their own classroom or school environment (e.g. crowded classroom sink or supply area with resulting pollution problem, crowded jungle gym, polluted lunch or playground area, etc.). Have them devise and actually implement some correction in the existing system or a new system to correct the problem. (Note: It is crucial that children start environmental education at this level rather than offer merely lip service to environmental solutions they cannot implement; otherwise, children talk about ecology and environmental protection in terms heard on television or from their parents but, at the same time, waste resources at school and pollute their own classroom areas.)

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